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PRACTICAL MATHEMATICS FOR HIGH SCHOOLS.

By W. H. Dooley.

One of the most constructive criticisms that have been made of secondary-school mathematics, by a general educator, was made by H. C. Morrison, State Commissioner of Education, of New Hampshire, when he said, "The traditional courses in algebra, geometry, trigonometry and advanced algebra must be revised as to organization and content to meet the need of the adolescent, and the social purpose of the high school . . . mathematics must be considered as a language to interpret science. . . . It must be presented to give immediate opportunity for functioning. It should be adapted to meet the needs of the different courses." These suggestions were offered after years of observation of high-school teaching of mathematics, and were no doubt due to the following causes: change in type of pupil in the high school; feeling that the industrial and commercial needs should be recognized in secondary-school mathematics; disbelief in the formal discipline theory.

The thoughtful student of education will ask why are complaints made about the subject of mathematics that has been in our course of study as a compulsory subject during the last century? An investigation will show that the high school was established primarily for a group of pupils who had intellectual taste—ability to pursue mathematics, foreign languages, history and science. During the last twenty years the high-school population has increased by leaps and bounds, out of proportion to the increase in population. For example, in the year 1899–1900, there were in the public high schools of the United States about 221,000 students, or about .36 of one per cent. of the population. In 1908–1909, these same public high schools had 863,000 students, or about one per cent. of the population. These figures show that within ten years the high-school population increased 300 per cent. The high schools were once patronized by the children of the professional classes, and especially those children who intended to enter the higher schools of learning, but the above statistics show that this is no longer true. In the minds of the people the high schools are becoming more popular, and there is a constantly increasing disposition to send children to high school in order to give them two or more years of education.

It is clear that the high school of to-day has children of all classes; those of the intellectual, the artistic and the practical type.

While the children who have a special genius or talent for the formal or abstract studies have been able to grasp the traditional course in mathematics, so as to pass the promotional tests, they have received little if any training in the application of mathematics to the trades and the home. They have graduated from the course in mathematics without being able to commercialize or apply the same to life. The other types of mentality have neither the interest nor the mental equipment for abstract mathematics, and invariably fail to meet the promotional tests. This accounts in some measure for the large percentage of failures.

If the modern high school expects to have efficient courses, it must supplement and rearrange its program in mathematics so as to meet the interests and mental equipment of all the boys and girls. This means that the school must teach every kind of mathematics which society employs in the conduct of its affairs; not only to encourage the study of each, but to give to every variety of mind that interest and growth in mathematics which is necessary to power and self-confidence. In attempting to do this, let us not destroy or weaken the effective work that is being done in pure mathematics for the child of intellectual interests.

The movement to adjust mathematics to the capacities and the practical needs of the pupils has already made some progress in the upper grades. The essentials of arithmetic are taught within the first six years of the elementary school. The last two years are devoted to a study of community business arithmetic, that is, a study of the application of arithmetic to simple problems. There is no logical reason why this movement should not extend to the first year and possibly for some pupils to the second year of the high school. Some teachers may feel that vocational mathematics should follow, rather than precede, the regular courses in algebra and geometry. The intellectual type of child may well take it, after the theory, if the same does not interfere with the preparatory work for college which is usually carried on very efficiently the last two years. For the other types of pupils, the vocational mathematics should be given during the first two years, otherwise the great majority who fail to complete over two years' work will leave school without this training.

Modern psychology teaches us that the attitude of the mind in learning mathematical principles is different from that utilized in applying the principles to situations; therefore a course in mathematics in a high school should include an effective training in the applications of principles in mathematics to the trades and industries that are common to every community. The majority of pupils will be obliged to earn their living in either the productive or distributing branches of these trades.

The question may be asked, What are the trades and industries common to every industry? For boys—wood-working, metal-working (including machine shop and sheet-metal work), plumbing, power-plants (including steam and electrical work) and the building trades. Oftentimes the community may have a single industry, such as textiles, tanning, boot and shoe manufacture and agriculture. The mathematics in use in these industries should also be taught. For girls—the true vocation of all women, homemaking, trained nursing, dressmaking, millinery, clerical work, etc.

The next question that may be asked is, How can the average teacher prepare himself or herself to teach the mathematics underlying these trades? The experience of the writer has been that this may be done in a very short time. The first step is for the teacher to visit the trade and make a collection of materials, hand-tools and illustrations of power-tools that involve mathematics. The teacher will soon acquire an appreciative knowledge of trade conditions and the types of problems used in each trade. With a well-graded text-book in the subject, the teacher will be equipped to handle a class.

The first part of every new subject should be devoted to a discussion of the subject-matter. Find out what the pupils already know, and then show the value of more knowledge on the subject. As far as possible the teacher should present the subject objectively, laying great emphasis on practical proofs (demonstrations) of mathematical principles. For example, in teaching the relation between the diameter of a pulley and the distance around it, ask a pupil to draw a chalk-line on the floor and then mark the face of the pulley at the beginning of the chalk-line. Then roll the pulley along the chalk-line for one complete revolution. The diameter of the pulley is the longest distance across the pulley. Dividing the distance around the pulley by the diameter will give the ratio of the diameter to the circumference—the constant π.

The keynote of to-day is thrift or conservation. The habit of thrift can be cultivated to a great degree through proper correlation of the home and school. The problems of the home may be made the basis of practical mathematics in school. Problems in homemaking should include distribution of income, based not only upon the problems of the text-book, but on the data obtained by members of the class. Each girl should keep to criticize the disbursements expressed in per cent. of the income in it. It should be balanced monthly and the pupil made to criticize the disbursement expressed in per cent. of the income. Constructive comments may be made by the teacher and other pupils, showing where improvements may be made. When mathematics of the home are well taught by an interesting teacher, it not only helps to introduce into the homes that methodical spirit which regulates expenses by receipts, and makes the product of thrift fruitful, which we need so much to-day, but develops an interest in the field of mathematics and shows that the study of this subject is worth while. Similar problems should be presented dealing with the vocational activities of women. Remember that all problems in vocational mathematics should be made to arise in a vital and natural way, so that the pupil will recognize the need for the training in the principles of mathematics which the teacher requires.

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